BIOLOGICAL BULLETIN

107434

EDITED BY

THE DIRECTOR
AND MEMBERS OF THE STAFF

OF

The Marine Biological Laboratory

WOODS HOLL, MASS.

VOLUME I

BOSTON, U.S.A.
GINN & COMPANY, PUBLISHERS
The Athenæum Press
1900

CONTENTS OF VOL. I

No. 1. — October, 1899.

PAGES

I. MAYNARD M. METCALF.
Some Relations between Nervous Tissue and Glandular Tissue in the Tunicata . . . 1–6

II. T. H. MORGAN.
Regeneration of Tissue composed of Parts of Two Species 7–14

III. ANNE MOORE.
Dinophilus Gardineri (*Sp. Nov.*) 15–18

IV. GARRY DE N. HOUGH.
Some Muscinae of North America 19–33

V. C. W. HARGITT.
Experimental Studies upon Hydromedusae . 35–51

BIBLIOGRAPHY AND PUBLICATION 53–56

No. 2. — January, 1900.

I. J. M. PRATHER.
The Early Stages in the Development of the Hypophysis of Amia Calva 57–80

II. VERNON L. KELLOGG.
An Extraordinary New Maritime Fly . . . 81–87

PAGES

III. P. CALVIN MENSCH.
On the Variation in the Position of the Stolon in Autolytus 89–93

IV. THOS. H. MONTGOMERY, JR.
Gordiacea from the Cope Collection 95–98

V. GUSTAV EISEN, PH.D.
A Preliminary Account of the Spermatogenesis of Batrachoseps Attenuatus, Polymorphous Spermatogonia, Auxocytes, and Spermatocytes 99–113

No. 3. — May, 1900.

I. S. J. HOLMES.
The Early Cleavage and Formation of the Mesoderm of Serpulorbis Squamigerus Carpenter 115–121

II. AXEL LEONARD MELANDER AND CHARLES THOMAS BRUES.
New Species of Hygroceleuthus and Dolichopus, with Remarks on Hygroceleuthus . 123–148

III. SHINKISHI HATAI.
On the Origin of the Sperm-Blastophore of some Aquatic Oligochaeta 149–154

IV. CHARLES THOMAS BRUES.
Peculiar Tracheal Dilatations in Bittacomorpha Clavipes Fabr. 155–160

V. ALBERT M. REESE.
Lampreys in Captivity 161–162

No. 4. — July, 1900.

PAGES

I. CHAS. B. WILSON.
Our North American Echiurids 163–178

II. JAMES G. NEEDHAM.
Some General Features of the Metamorphosis of the Flag Weevil Mononychus Vulpeculus Fabr. 179–191

III. C. C. LEMON.
Notes on the Physiology of Regeneration of Parts in Planaria Maculata 193–204

IV. JOSEPHINE HEMENWAY.
The Structure of the Eye of Scutigera (Cermatia) Forceps 205–213

No. 5. — August, 1900.

I. C. M. CHILD.
Abnormalities in the Cestode Moniezia Expansa. I. 215–250

II. AUGUSTA RÜCKER.
A Description of the Male of Peripatus Eisenii Wheeler 251–259

No. 6. — September, 1900.

I. C. M. CHILD.
Abnormalities in the Cestode Moniezia Expansa. II. 261–290

II. CARRIE M. ALLEN.
A Contribution to the Development of Parypha Crocea 291–315

Volume I.] *October, 1899.* [*No. 1.*

BIOLOGICAL BULLETIN.

SOME RELATIONS BETWEEN NERVOUS TISSUE AND GLANDULAR TISSUE IN THE TUNICATA.

MAYNARD M. METCALF.

IT is well known that in the ascidians the definitive brain and the neural gland are both derived from the same region — the trunk region of the central nerve tube of the tadpole. The ganglion is derived from one wall of this tube, and the gland is derived from the opposite wall. Six years ago I pointed out that the ganglion of *Salpa* is homologous with both the ganglion and the neural gland of ascidians; the dorsal part of the *Salpa* ganglion corresponding to the ascidian brain, and its ventral part corresponding to the ascidian neural gland.[1] That is, a certain portion of the embryonic nervous system in ascidians becomes transformed into the neural gland, while in *Salpa* the corresponding region does not suffer this change, but remains as part of the definitive brain, its cells functioning as gland cells in the adult. I have recently found in the ascidians an interesting series of diverse conditions as to the origin of the gangliated nerve which runs down in the median line of the partition between pharynx and cloaca.

In this region, the dorsal raphe, one finds a large blood sinus, a muscle (either single or double), a gangliated nerve cord (the rapheal nerve), and frequently a prolongation from the neural

[1] "The Eyes and Sub-Neural Gland of Salpa," *Memoirs from the Biological Laboratory of the Johns Hopkins University*. Vol. ii, Part iv. 1893.

gland, which I have called the rapheal duct. In different species the rapheal nerve may arise from the cellular cortex of the brain, from the neural gland, or from a mass of cells formed by the fusion of the brain and the gland. The five accompanying diagrams show some of the conditions found.

In *Cynthia papillosa*, Fig. 1, the rapheal nerve arises from the cellular cortex of the brain. Alongside it in the raphe is found the unusually large rapheal duct, which has extended down from near the posterior end of the epineural gland. The rapheal duct and rapheal nerve are wholly distinct.

In *Distaplia magnilarva*, Fig. 2, there is no rapheal duct. The brain and neural gland are united posteriorly. The rapheal nerve arises from the cortex of the brain, a little behind the point of fusion of the brain with the gland.

In *Amaroecium constellatum*, Fig. 3, we find a rudimentary rapheal duct starting back from the gland, but it looses its lumen before going far, and then its cells become united with the cells of the brain to form a common mass of cells whose origin, whether from the brain or the gland, we are unable to determine. From this common mass of cells the *ganglion cells* of the rapheal nerve are derived, its *fibers* coming from the right posterior siphonal nerve.

In *Ascidia atra*, Fig. 4, we have a similar origin for the fibers of the rapheal nerve, but find an interesting difference in the derivation of its ganglion cells. A cord of cells pushes out from the dorsal surface of the brain, near its posterior end, and, after running back a short distance, unites with a backward prolongation of the gland, which runs up to meet it. The prolongation of the gland is evidently the rapheal duct. The two cords fuse immediately, the duct loosing its lumen. The single cord of cells thus formed runs back some distance and then bends down to accompany the fibers of the rapheal nerve. Its cells soon become loosely arranged among these nerve fibers and are clearly the ganglion cells of the rapheal nerve.

In *Phallusia mammillata*, Fig. 5, these organs are exactly similar, except that the prolongation from the dorsal surface of the ganglion does not unite with the rapheal duct, but bends forward, soon ending blindly. In this species, then, the ganglion

cells of the rapheal nerve are derived solely from the rapheal duct, which is a prolongation from the neural gland.

The ganglion cells of the rapheal nerve in *Phallusia* have therefore had a roundabout history. Certain cells of the larval nerve tube were pushed out to form the neural gland. A portion of these gland cells extended backward until they came in contact with the fibers of the rapheal nerve.[1] Here they lose their regular arrangement and become the ganglion cells of the nerve. There is no evidence that these particular cells, even though a part of the gland, were ever functional as glandular cells. The corresponding cells, however, in many other species are functional gland cells. (Compare *Cynthia papillosa* above.)

The facts referred to in this paper show a peculiarly intimate relation between glandular tissue and nervous tissue in the *Tunicata*, hardly to be paralleled elsewhere in the animal kingdom.

THE MARINE BIOLOGICAL LABORATORY,
WOODS HOLL, MASS.,
July 20, 1899.

[1] This is based upon the assumption that the rapheal duct arises as a down-growth from the definitive gland rather than by the metamorphosis *in situ* of the trunk portion of the nerve tube of the tadpole. The rapheal nerve in *Salpa* and probably in ascidians arises as a down-growth from the brain. It is probable that the rapheal duct arises in a similar way as a down-growth from the definitive gland.

EXPLANATION OF FIGURES.

Reference Letters.

a.s.n. = anterior siphonal nerve.
d. = duct from neural gland to ciliated funnel.
f.r.n. = fibers of rapheal nerve.
g.c. = cord of ganglion cells.
gg. = ganglion (brain).
gl. = neural gland.
g.r.n. = ganglion cells of rapheal nerve.
p.s.n. = posterior siphonal nerve.
r.d. = rapheal duct.
r.n. = rapheal nerve.

The figures are diagrammatic parasagittal sections of the ganglion and neural gland, a little to the right of the median plane. In Figs. 4 and 5 the rapheal duct, which in reality lies on the right surface of the ganglion, is shown, although in reality it lies much to the right of the plane of the rest of the section.

FIG. 1. Cynthia papillosa.
FIG. 2. Distaplia magnilarva.
FIG. 3. Amaroecium constellatum.
FIG. 4. Ascidia atra.
FIG. 5. Phallusia mammillata.

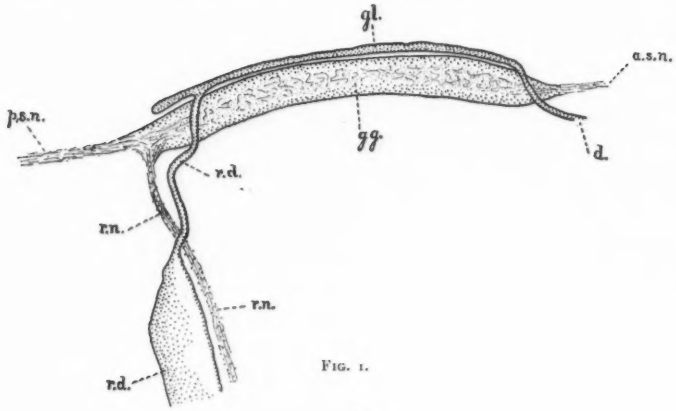


FIG. 1.

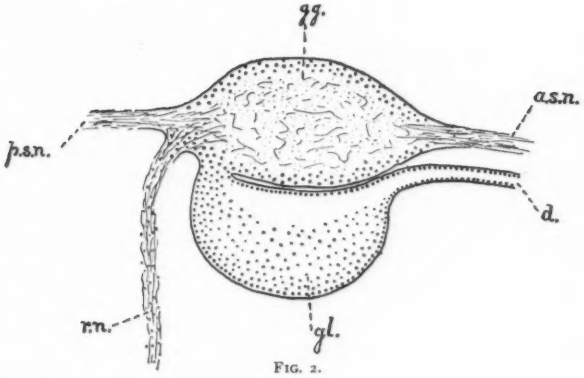


FIG. 2.

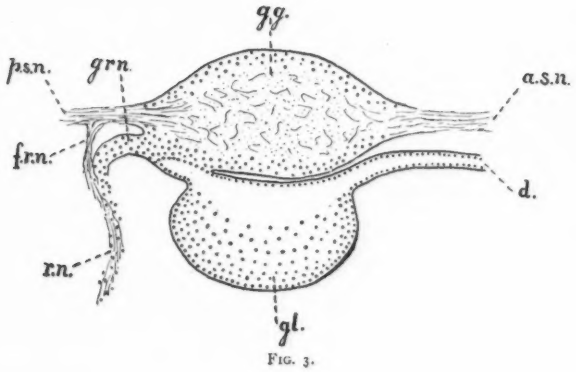


FIG. 3.

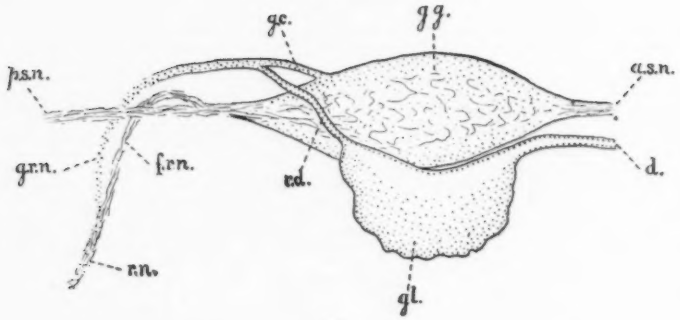


FIG. 4.

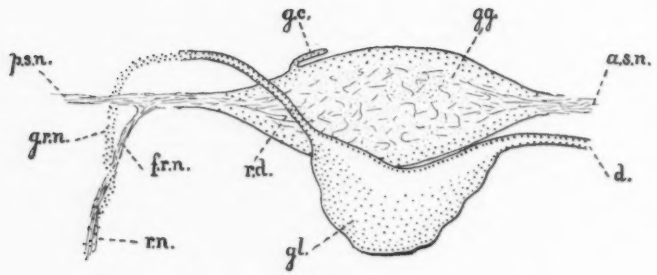


FIG. 5.

REGENERATION OF TISSUE COMPOSED OF PARTS OF TWO SPECIES.

T. H. MORGAN.

BORN's experiments in grafting together tadpoles of different species of frogs have demonstrated that each part, whether large or small, retains the characteristics of the species to which it belongs. During the development of an animal, formed by the union of parts of two species, the tissues do not influence each other, but each develops its own specific peculiarities.

Joest has shown that when parts of two different species of earthworms are grafted together each part retains its specific characters. He has further shown that if, after grafting, a portion of one of the parts is cut off, the new part that is regenerated is like the part from which it immediately arises, and is not influenced by the part belonging to the other species, even when the latter is very large, and the former (that from which the new part arises) is very small.

Many experiments have been made with plants in which different species have been grafted together, and the subsequent growth of the two parts studied. Vöchting, who has given a detailed account of these experiments and has made others himself, has shown that in general no influence of a specific character is transmitted from one part to the other, although in certain cases[1] the parts do have some influence on each other.

The following experiments were made, not so much to determine whether the tissues of one component of a graft influence the kind of regeneration of the other, since this point seemed fairly settled by Joest and by Harrison, but I hoped to find out if new tissue, made up of cells derived from parts of two species, showed any mixing of the specific characters of the two species.

[1] Particularly in those cases where annual and biennial varieties are grafted together.

It seemed possible, at least, that new tissue, composed of cells derived from two species, might show the influence of its dual origin.

Harrison[1] has shown that the tails of young tadpoles may be interchanged even when two species are used, and that later the ectoderm of the body of the larger component grows out over the base of the grafted tail, slipping over the region where the tail has been grafted on, as shown in Fig. 1. If two species be used, and then, after the tail has grown to the stage shown in this figure, the tail be cut off just distal to the point of union, as shown in Fig. 2 by the vertical line, there will be present at the exposed end two kinds of tissue — the ectoderm, which is the same as that covering the body of the tadpole, and the inner tissue, composed of muscles, connective tissue, pig-

FIG. 1. (After Harrison.)

ment cells, notochord and nerve cord, that belong to the grafted tail. Under these circumstances the new tail that regenerates will be made up of parts of two species. Harrison carried out an experiment of this sort. He writes[2] in regard to the result: "The tail of a larva of *R. virescens* was replaced by the tail of a larva of *R. palustris*, in the manner described above. Forty-eight hours later, at which time the sketch was made (see Fig. 1), the tail was amputated. The epidermis from the virescens body had then pushed out considerably over the root of the tail, so that in cutting, almost all of the grafted epidermis (stippled in the figure) was removed. But a considerable portion of the underlying organs of the transplanted piece (shaded in the figure) remained, and it was from this component that regeneration took place in all the tissues, with the exception of part of the epidermis. The newly grown tail was

[1] Harrison, R. G., "The Growth and Regeneration of the Tail of the Frog Larva," *Roux's Archiv.* Vol. vii, 1898. [2] Page 473. Case 13.

of normal form, and, as far as could be observed, it had the characteristics of the species of the grafted stump (palustris) and not those of the body (virescens). This was seen in the character of the pigmentation, and especially in the absence of the large black blotches along the side of the tail, which are found constantly in the regenerated appendages of *R. virescens*. In spite of the insignificant size of the grafted stump, as compared with the whole body, and in spite of the fact that the nourishment conveyed to the growing appendage is brought there in blood, which is largely derived from the body, the tissues maintain their specific characters.[1]"

By using two species in which there is a marked difference in the pigmentation of the ectoderm and also some distinctive difference in the color of the pigment cells in the mesoderm, I hoped to be able to determine more definitely the character of the new part, and further, by observing the tissues of the two species, where they are regenerating side by side, to see if they mutually influence each other. The problem is somewhat different from the one Harrison examined, since I was less concerned with the influence of the major component on the new regenerating part than with the possibility of a mutual influence of the new cells on each other. Harrison has shown, with some degree of probability, that the former influence is not shown in the new part, but the latter problem is not specially considered.

I have found it possible to graft together two such differently pigmented tadpoles as *Rana* (*temporaria*) *sylvatica* and *R. palustris*. The former breeds earlier, but the development will be retarded several weeks if the dishes in which the tadpoles are placed be put on ice in an ice chest. It is better to let the tadpoles develop as far as the stage when the tail-knob is just about to appear, since at this stage they withstand better

[1] "I had hoped to obtain more definite evidence concerning the influences which regulate regeneration, from experiments carried out along these lines. But, owing to unfortunate circumstances, most of the larvae of this series died. Besides, all regenerated tails deviate somewhat from the normal type, especially as regards pigmentation, which fact would bring in a considerable element of uncertainty, and in the tail I have not been able to find any other characters which could with safety be considered diagnostic of either species."

the effect of the ice-cold water. If segmenting eggs or the early gastrula stages be put on ice they are killed after several days, although the latter stages withstand the cold longer than the former. The young tadpoles do not seem to be in the least injured, and may even slowly continue to develop, but at so slow a rate that after three weeks the tail had grown only a very little. Since in this locality the eggs of *R. palustris* can be obtained in great abundance for a period of at least two weeks, I have had plenty of material of both species.

The tadpoles were operated upon at the time when they had reached the age shown in Harrison's Fig. 2. They were still in the jelly membranes. Muscular movements of the body had scarcely begun at this time. The tadpoles were held in place by small pieces of aluminium wire. Silver wire used by Born and by Harrison would probably be better, since it is heavier.

The young tadpole of *R. sylvatica* is very black, the color being due to the deeply pigmented ectoderm and to some extent to pigment in the mesoderm. The young tadpole of *R. palustris* is much lighter in color. The ectoderm contains a yellowish pigment, and the pigment cells of the mesoderm are lighter in color than those of the other species. After grafting together parts of these two species, the difference in color of the two parts is so marked that it can be easily seen with the naked eye. Under the microscope one can tell readily whether an individual cell in the ectoderm belongs to the one or to the other species. In later stages, when the ectoderm has become clearer, the two kinds of cells can no longer be distinguished without a microscope. The core of the tail of *R. sylvatica* is much darker than that of *R. palustris*, and the line of union of the two can be seen with the unaided eye.

As the tadpole grows larger, it will be found that the ectoderm of the smaller component grows less rapidly than the rest of the tail, and as a result the ectoderm of the larger component extends over the base of the grafted tail, as Harrison has stated (Figs. 2 and 3). The tadpoles were allowed to grow for about ten days, or somewhat longer,[1] and then the tail was cut off in various ways.

[1] It would have been better to have cut the tail off sooner, since the difference in the ectoderm of the two species is less marked in later stages.

Experiment I. — The tail of *R. palustris* had been grafted upon the body of *R. sylvatica*. The tadpole appeared at the time of the second operation, as shown in Fig. 2 *A* (April 25). The dark ectoderm of the major component — *R. sylvatica* — had grown out over the base of the tail of the smaller com-

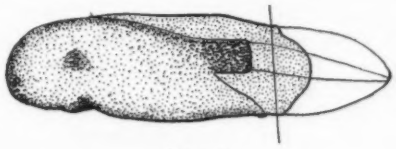


FIG. 2 *A*.

ponent (*R. palustris*). The region of union of the inner tissue can be seen where the dark and the light parts meet. The tail was then cut off, as shown by the vertical line in the figure. In consequence, there was left exposed at the cut end of the tail

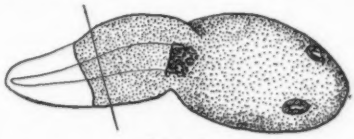


FIG. 2 *B*.

the inner tissues derived from *R. palustris*, and the outer from *R. sylvatica*. A new tail began to regenerate, and during all of its subsequent development the new tail was made up of ectoderm exactly like that of the major component, and of inner

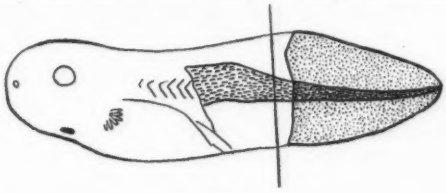


FIG. 3.

tissue whose pigment cells resembled those of the minor component. In other words, both inner and outer tissues regenerated their kind and showed no commingling of characters.

Experiment II. — In this experiment the major component was *R. palustris* and the minor *R. sylvatica*. After the new

tail had reached the stage shown in Fig. 3, it was cut off as indicated by the vertical line. There was left exposed at the cut end the light-colored ectoderm of the major component and the inner tissues of the minor component. The new tail that developed had light ectoderm on the surface and a dark interior. Each part regenerated its specific tissue and was uninfluenced by the developing tissue of the other species.

Two points present themselves for consideration. If the tail of an ordinary tadpole be cut off and subsequently develop, does the regenerated tail show the specific characters of the normal tail or is it different? I have examined the regenerated tails of both species and find that both the ectoderm and the mesodermal pigment cells are like those of a normal tail. It is, however, not very uncommon, both in regenerated tails of normal tadpoles and also in grafted tadpoles, to find the mesodermal pigment cells imperfectly developed, and in such cases the specific character of the cells is not obvious; but in all cases in which the pigment cells are well developed, the specific character is readily seen, especially in the cells lying along the central part of the tail. It should be stated, however, that I have occasionally found isolated cells whose character was doubtful, but the large majority of cells are unquestionably like those of the tissue from which the new tail arises. The second question is whether the ectoderm forms new cells over the new part, or does the old ectoderm simply extend out over the new part? There is the appearance in the regenerating tail of the formation of a new ectoderm at the tip of the new tail, where the cells are more crowded together and smaller than over the base of the tail. It is not improbable that in addition to this new ectoderm the old ectoderm extends also over a part of the new tail.

Experiment III. — In several cases the tail was cut off obliquely, in much the same way as in Harrison's experiment. Owing to the difference in pigmentation of the two kinds of ectoderm, I could follow the subsequent history of each and determine whether, along their line of contact, and in the region where new cells are developing, the specific characters of the cells are altered.

As shown in Fig. 4, the tail of a tadpole, in which the major component is *R. palustris* and the minor *R. sylvatica*, was cut off obliquely, leaving a small amount of the dark ectoderm of *R. sylvatica* on the upper side. The inner cells at the cut edge all belonged to *R. sylvatica*. When the new tail developed, it showed along its upper part the dark ectoderm of *R. sylvatica*, that had developed from the small piece left at the time of the

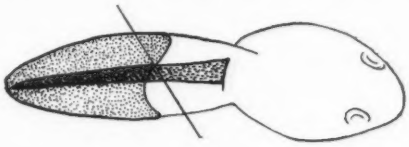


FIG. 4.

operation. The area covered by the dark ectoderm was greater than that left after the tail was cut off, but it cannot be stated how much of this increase is due to the cells becoming flatter and how much to new cells formed at the free edge.

In another similar experiment, in which, however, the major component was the dark species, *R. sylvatica*, and the minor the paler species, *R. palustris*, the tail was cut off (April 27), as shown in Fig. 5. A large area of light ectoderm was left on the dorsal surface of the tail, and only a small amount of the

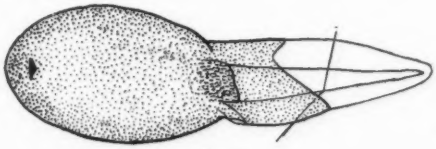


FIG. 5.

black ectoderm came to the edge of the lower part. On May 10, when the new tail was fairly well developed, it was found to have its upper surface covered by light-colored ectoderm, and its lower by dark ectoderm, while the interior mesodermal pigment cells were like those of *R. palustris*. Each tissue had regenerated its like, and the light ectoderm of the minor component showed no influence of the other, dark ectoderm, even along the line of contact where new cells were developing.

In addition to these experiments I have records of four others similar to Experiment I (Fig. 2, *A*, *B*); three others similar to Experiment II (Fig. 3); and four others in which the tail was cut off obliquely, leaving both kinds of ectoderm at the cut edge. In all cases the specific character of the new tissue was like that of the old tissue from which it arose.

At first the difference in the ectoderm of the two species is very marked, but as the tadpoles get older the ectoderm seems to flatten and become more transparent, so that in these tadpoles it is difficult to distinguish between the two kinds of ectoderm. But if the tadpoles are examined every day one can detect differences in the two kinds of ectoderm for a longer period than could be done by casual observations alone. Wherever the ectoderm has not spread out, particularly at the tip of the tail, the dark pigmented cells of *R. sylvatica* and the yellowish cells of *R. palustris* can be readily detected. The pigment cells in the mesoderm assume their characteristic arrangement during the older stages, and as the ectoderm becomes more transparent, the cells can be easily seen in the living tadpoles. The tadpoles were all kept under the same condition, so that the effect of light on the pigment cells would be approximately the same in all experiments.

Unfortunately the differences in pigmentation are the only specific characters that can be made out readily in these tadpoles, but I think there can be little doubt that if the cells retain their characteristic pigmentation they also retain their other peculiarities.

We may conclude with some degree of probability that during regeneration in a region where the cells have been derived from two different species, each kind of new cell retains the character of the cells from which it is derived, and the specific characters of the cells of one species are not transmitted to the cells of the other species, although the developing cells in the new tissue may be in actual contact.

DINOPHILUS GARDINERI (*Sp. Nov.*).

ANNE MOORE.

Preliminary Note.

A new species of *Dinophilus* was found in the summer of 1897, by Dr. E. G. Gardiner, at Woods Holl. The pool in which it is found is an artificial one, 12 by 14 feet, dug about eight years ago to obtain the peat in the marsh. Sea water does not flow into it, but when the tide is unusually high it percolates in through the sand. The salinity of the water is therefore subject to great variation, for a run of low tides results in condensation through evaporation, while heavy rains dilute it. In May, 1898 and 1899, *Dinophilus* was found by Dr. Gardiner in abundance upon green algae floating on the surface of the water. In June, 1898, he kindly brought the animal to my notice and I began work upon it. At that time it was not abundant, and by July 16 had entirely disappeared. In 1899 only two specimens were seen after June 28. Both years the disappearance was coincident with a rainstorm, so that it is quite possible that the influx of fresh water may account for it. Other observers (Hallez,[1] Weldon,[2] Harmer [3]) have noted the periodical disappearance of *Dinophilus*. Weldon attributes it to the disintegration of the female, consequent upon the setting free of the ova, but Schimkewitsch [4] maintains that eggs may be laid several times during the year, and that the female lives for some time after depositing them. He found special ducts present for carrying the eggs to the exterior, so that there

[1] Hallez, P., *Contributions à l'Histoire Naturelle des Turbellaires*. Lille, 1879, p. 155. (D. metameroides.)

[2] Weldon, W. F. R., "On Dinophilus gigas," *Quart. Journ. Micr. Sci.* Vol. xxvii. 1887.

[3] Harmer, S. F., "Notes on the Anatomy of Dinophilus," p. 109, *Journ. Mar. Biol. Ass. of United Kingdoms*. New Series. Vol. ii, October, 1899.

[4] Schimkewitsch, W., "Zur Kenntnis des Baues und der Entwicklung des Dinophilus vom Wei Ben Meere," *Zeit. für wiss. Zool.* Bd. lix. 1895.

is no necessity for disintegration to set them free. Of the disappearance of the animal, and a possible explanation of it, I will speak later.

This species of *Dinophilus*, which I take pleasure in calling *D. Gardineri*, differs in certain features from those species which have been noted by other observers. It is easily recognized without a lens, for its bright orange-red pigment makes a sharp contrast with the green algae upon which it is found. The average length of the form is about 1 mm., but under a dissecting lens the highly colored intestine, with its characteristic stomach portion, and the red kidney-shaped eyes, are noticeable features. The body is about three times as long as it is broad, the proportions varying, of course, with extension or contraction; it is somewhat flattened dorso-ventrally, and when fully extended tapers toward the posterior end. It consists of six definite segments, exclusive of head and tail, distinctly visible in young individuals in a state of extension (Fig. 2). Neither young nor old individuals show segmentation when contracted, and old ones show it only when making a turn, not when moving rapidly in full extension. The head is rounded in front and bears the eyes on its dorsal surface (Fig. 1). The mouth is situated on the ventral surface posterior to the eyes at, or just anterior to, the union of the head with the first body segment. The small unsegmented tail approximates the length of a body segment. It is considerably narrower than the body and tapers to a point. The anus is situated dorsally to its base. Owing to the scarcity of material, I did not ascertain to my satisfaction the arrangement of the cilia, but as nearly as I could determine the animal is com-

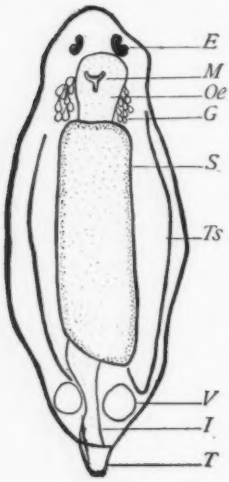


FIG. 1.

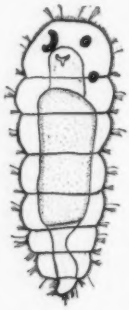


FIG. 2.

pletely ciliated, and, in addition, each segment shows laterally two tufts of long cilia and a strong bristle anteriorly placed. These probably indicate the presence of two rings of cilia on each segment. The head bears two tufts of long cilia in front, and the tail bears several bristles. These are probably of a sensory nature.

No sexual dimorphism is present; it is impossible to distinguish the sex of young individuals. In mature females the paired ovaries are strongly colored and may be clearly seen.

This species differs from *D. gyrociliatus* (*apatris*) and *D. metameroides* in its lack of sexual dimorphism; in the number of segments and in the arrangement of cilia it differs from *D. gigas* (7 segments), *D. taeniatus* (5 segments), *D. pygmaeus* (5 segments), and *D. simplex* (4 segments); in the arrangement of cilia and in the possession of an unsegmented tail it differs from *D. vorticoides* (*caudatus*).

The bilobed or crescentic shape of the eyes of *Dinophilus* often looks as if they were on the way to becoming double, as is the case with some *Turbellaria*. I have found two specimens in which the right eye was made up of two spheres completely separated from each other. In one case they lay close together; in the other, one sphere was in the normal position, the other in the next segment (Fig. 2).

In explanation of the disappearance of *Dinophilus*, alluded to above, I have to offer an observation of a stage in its life history which to my knowledge has not been noted before. On June 27, 1899, in my search for specimens I came across capsules imbedded in the tangle of algae. Through the thin transparent walls I could distinctly see the characteristic form, color, and eyes of *Dinophilus*. In addition to the capsules, eight specimens were found on the same day. These were put by themselves in a shallow glass dish containing salt water and some algae, and were watered from day to day. At the end of a week only five specimens were seen; on searching for the other three, three capsules were found. I then realized that these capsules really represented an encysted stage of *Dinophilus*. The five remaining specimens were transferred to a fresh dish of clear water. Four of them disintegrated;

the fifth formed a cyst. Every stage of the process was watched. The animal became perfectly quiet, and a clear secretion was given off. After a time, probably from a sense of discomfort, it moved away from this secretion, leaving behind it an impression of its form. These impressions had been seen before, but it was not known to what they were due. After moving, the animal continued to give off the secretion, and at the end of the next day the capsule was completed, the whole process taking three days. The other individuals began to secrete in the same way, but in one case the animal was disturbed and the process stopped, and in the others they were attacked by protozoa, causing disintegration. The largest cyst that was found measured .5 mm., the smallest .13 mm. This decrease in size might easily account for their being overlooked, but in addition to this it was found that after keeping the cyst for a time the color faded out so that it became practically unrecognizable.

It is quite probable that this cyst is formed through the activity of numerous gland cells in the skin. Many observers have noted these glands, but no one has suggested an adequate function for them.

The affinities of *Dinophilus* and its systematic position make it a peculiarly interesting form, and I hope in a more favorable year to obtain sufficient material to complete my work upon it.

THE MARINE BIOLOGICAL LABORATORY,
WOODS HOLL, AUG. 6, 1899.

SOME MUSCINAE OF NORTH AMERICA.

GARRY DE N. HOUGH, M.D.

GIRSCHNER divides the *Muscidea* into two series — *Calyptratae* and *Acalyptratae*. The former he divides into two families, one of which is the *Anthomyidae*. Hypopleural bristles lacking. If three sternopleural bristles are present, they always have the arrangement 1 : 2 (*i.e.*, one in front and two behind). Ventral membrane usually present. Elbow of fourth longitudinal vein (if there is any) without an appendix.

This family Girschner divides into three groups:

1. *Coenosiinae.* — Fifth ventral segment of the male heart-shaped or split in the median line from the caudal border to a point beyond the middle. Fourth longitudinal vein straight. Abdomen usually elongate. Sternopleural bristles present. Squamulae separated from one another by an interspace that is broad to the very bottom; squamula thoracalis never broadened towards the scutellum.

2. *Muscinae.* — Fifth ventral segment of the male with its caudal border straight or moderately concave (lunulate), at any rate not split beyond the middle, except in *Lispe*, where it is three-pronged. Fourth longitudinal vein straight or more or less bent up toward the third in the form of an apical cross-vein. Abdomen usually short or long oval. Sternopleural bristles present. Squamulae not separated from one another, in contact at their attached borders; angle between them narrow and acute.

3. *Gastrophilinae.* — Sternopleural bristles absent. Fourth vein straight. Costal vein reaching only to or a little beyond the third vein. Squamulae but little developed, separated from one another by a projecting angle.

The *Muscinae* are divided into three sections:

a. *Muscinae coenosiaeformes.* — Front broad in both sexes.

Squamula thoracalis not broadened mesad and caudad. Wings not rilled.[1]

b. *Muscinae ariciaeformes.* — Front narrow in the male, broad in the female. Squamula thoracalis not broadened mesad and caudad. Wings in the most recent forms (geologically speaking, the "youngest") rilled.

c. *Muscinae muscaeformes.* — Front as in b. Squamula thoracalis broadened out mesad and caudad as far as the edge of the scutellum. Wings rilled. Apical cross-vein present.

Girschner's family *Anthomyidae* includes, in the first two groups, the *Anthomyidae* and part of the *Muscidae* (sens. strict.) of other authors. The genera belonging to the former have been made the subject of a recent paper by Mr. Paul Stein in the *Berl. Ent. Zeit.*, Vol. XLII, pp. 151–288, 1897. This paper covers the *Coenosiinae*;[2] the *Muscinae coenosiaeformes;* and the *Muscinae ariciaeformes*, except the genera *Myospila*, *Muscina*, *Clinopera*, *Hemichlora*, *Stomoxys*, and *Haematobia*. In these genera the fourth longitudinal vein is bent up, near its apical end, towards the third, and the arista is either pectinate or long plumose. They may be separated from one another as follows:

1. Proboscis long, slender, horny, adapted for piercing . . . 2
   Proboscis not so constructed, provided at the tip with fleshy labellae 3
2. Palpi much shorter than the proboscis, arista pectinate *Stomoxys* Geoffroy
   Palpi nearly as long as the proboscis, arista pectinate, sometimes also with a few hairs below . . . . *Haematobia* Desvoidy
3. Arista pectinate . . . . . *Hemichlora* v. d. Wulp
   Arista plumose 4
4. Sternopleural macrochaetae 2 : 2; eyes hairy . *Myospila* Rondan
   Sternopleural macrochaetae 1 : 2; eyes not hairy 5
5. First longitudinal vein ends far beyond the middle of the costa. One or more well-developed pairs of anterior acrostichal bristles *Muscina* Desvoidy
   First longitudinal vein ends before the middle of the costa. No anterior acrostichal macrochaetae . . . *Clinopera* v. d. Wulp

[1] These rills are very fine grooves in the surface of the wing which run in a sort of radiate manner toward the border. They are very numerous. A rilled wing denotes a higher stage of development, a more recent form, than an unrilled wing.

[2] Girschner's *Coenosiinae* includes a few genera which are commonly considered as members of the Acalyptrate family *Scatomyzidae;* these genera are not considered by Mr. Stein.

Stomoxys. — I have seen but one American species of this genus, which is the well-known "Stable Fly," *S. calcitrans* L. (Fig. 1, wing and chaetotaxy), very common both in Europe and this country. Of the species mentioned in Osten-Sacken's *Catalog*, *dira* Desv. and *inimica* Desv. are varieties of *calcitrans; occidentis* Walk. and *parasita* Fabr. are expressly stated to have plumose antennae, and must therefore belong to some other genus. As to *S. cybira* Walk., Walker himself questions its position in this genus. *S. calcitrans* L. is a brownish gray fly; its thorax has three rather broad, whitish stripes; on each border

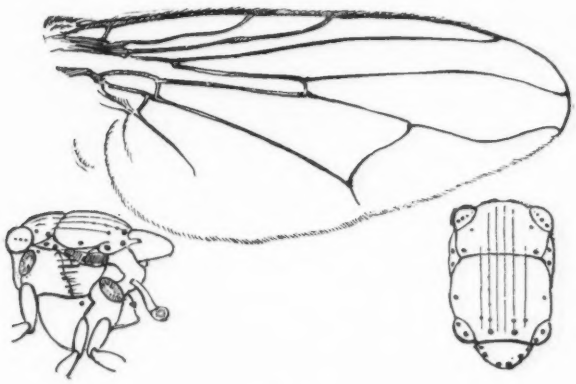


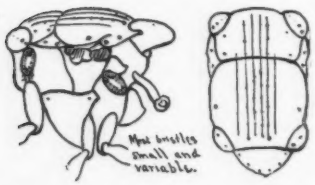
FIG. 1.

of the middle stripe and on the mesal borders of the lateral stripes is a blackish brown line; abdomen yellowish brown; on the second, third, and fourth segments are three brown spots which may be faint or even absent; wings hyaline or tinged with brown at base and along the costa. It has seemed to me that specimens taken on the borders of woods are more likely to have the brownish wings. Antennae brown; palpi yellowish brown; legs blackish brown, with yellowish or reddish knees.

Haematobia. — Two American species are known: *H. serrata* Desv. (Fig. 2 *a*), the "Horn Fly," an unpleasant importation from southern Europe, and *H. alcis*. Snow (Fig. 2 *b*), found by Professor Dyche in the cranberry swamps of northern Minnesota.

The two species are easily separated by the following points: hind tarsi of male serrate in *serrata*, not so in *alcis;* palpi black in *serrata*, yellow in *alcis;* pile of bucca black in *alcis*, yellow in *serrata;* at cephalo-dorsal angle of mesopleura *alcis*

FIG. 2 *a*.



has a large macrochaeta curved dorsad; *serrata* has no macrochaeta at this point; at the cephalo-ventral angle of the mesopleura (protecting the prostigma) *alcis* has two small bristles; *serrata* has a tuft of golden yellow hairs; *serrata* has much longer and denser pile on the dorsum of the thorax. Other color differences are pointed out by Professor Snow in connection with his description of *alcis* in *Can. Ent.*, April, 1891. I am much indebted to the Entomological Department of Kansas University for a pair of specimens of *H. alcis* which have enabled me to ascertain the important differences in the chaetotaxy of the mesopleurae above mentioned.

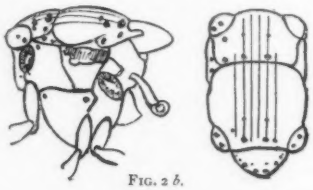


FIG. 2 *b*.

Hemichlora. — Only known species and type of genus *H. vittigera* Bigot, Mexico. Professor Williston, in his *Manual of North American Diptera*, p. 143, suggests parenthetically that this may be the *Idia viridis* of Wiedemann (*Auss. Zweif.*, Vol. II, pp. 354, 11). I quite agree with this suggestion for the following reasons. Meigen founded the genus *Idia* in 1826, and in his characterization (*Syst. Beschr. Eur. Zweif.*, Vol. V, p. 9) the only distinguishing character is the pectinate arista. To this Wiedemann (*loc. cit.*, p. 347) adds: face prolonged forwards

below and entirely without hair. Wiedemann's description of *Idia viridis* is based on one poorly preserved and greasy specimen and reads: "With black antennae, everywhere bronzy green, with hyaline wings and blackish legs. Face and front rusty brown, the green color dark, tending toward emerald green." *Hemichlora* has the pectinate arista, a slightly prominent oral margin, and is in part of a metallic blue color. A metallic blue color may vary to metallic green. Certainly *Hemichlora vittigera* comes nearer to the description of *Idia viridis* than any other known North American Muscid. No other *Idia* has been described from North America, and only the original specimen of *I. viridis* is known.

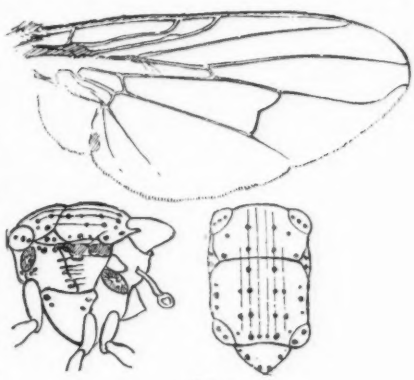


Fig. 3.

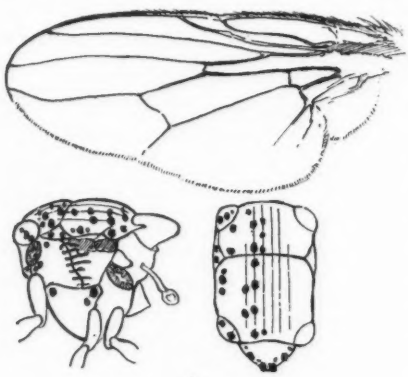


Fig. 4.

Myospila.— There is but one known North American species, *M. meditabunda* Fabr. (Fig. 3). It is common to Europe and America. Many of our specimens have the pubescence of the eyes very short; in the females sometimes it is very difficult to make out with an amplification of twenty diameters. No other difference am I able to find between European and American specimens. It seems to me very probable that *Cyrtoneura quadrisetosa* Thomson (*Eugen. Resa*, p. 549) is one of those

specimens whose eyes are almost bare. I have seen such specimens from California.

Muscina. — Until within a few years our species of *Muscina* have been referred to *Cyrtoneura*. Such authorities as van der Wulp and Williston are of the opinion that *Cyrtoneura* is a badly conceived genus and that the name should be dropped, the species formerly referred to it being divided among the genera *Muscina*, *Clinopera*, *Hemichlora*, and *Morellia*. Similarly, *Cyrtoneurina* should be dropped as a generic name, its species being distributed among some of the genera just mentioned. Following van der Wulp's views in cases where the species are unknown to me, the following are the known North American species of *Muscina*: *stabulans* Fall., *assimilis* Fall., *mexicana* Macq., *pallidicornis* Bigot, *parilis* Gigl.-Tos, *vecta* Gigl.-Tos, *linea* v. d. W., *tripuncata* v. d. W., *aurantiaca* nov. sp., and *texana* nov. sp. The species that I know may be separated by this table:

FIG. 5.

FIG. 6.

1. Legs wholly or partly yellow; palpi yellow 3
2. Legs wholly black 4
3. Antennae brown; three pairs acrostichal bristles cephalad the transverse suture; prostigma brown; humeri concolorous with thorax . . . *stabulans* Fall. (Fig. 4)

Antennae pale yellow; one pair acrostichals cephalad the suture; prostigma whitish yellow; humeri not concolorous with thorax *texana* nov. sp. (Fig. 7)

4. Palpi and antennae . . . . . *assimilis* Fall. (Fig. 5)
Palpi and antennae orange yellow . *aurantiaca* nov. sp. (Fig. 6)

M. aurantiaca nov. sp. — Male and female; several specimens collected by Mr. G. R. Pilate at Tifton, Ga. General appearance like that of *stabulans*, *assimilis*, and *pabulorum*, *i.e.*, with gray-striped thorax and abdomen with variable spots. Chaetotaxy like stabulans, etc.

M. texana nov. sp. — Two males, Texas. Agrees very closely with Giglio-Tos's descriptions of *M. parilis* and *M. vecta*, from which its rather broad front, with the series of transfrontal

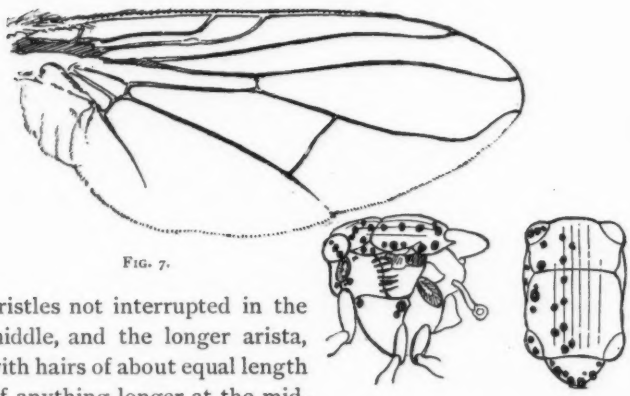


FIG. 7.

bristles not interrupted in the middle, and the longer arista, with hairs of about equal length (if anything longer at the middle of the arista than at the base), and much more scattered than in *vecta* and *parilis*, clearly separate it. The same characters separate it from *M. linea* v. d. W. I separate it from *tripunctata* v. d. W. because of the striking appearance of the prostigma, which I think Mr. van der Wulp would hardly have failed to note had it been present in his specimens.

Clinopera (Fig. 8, *C. inuber* G.-Tos). — Mr. van der Wulp describes in *Biologia Centrali Americana* seven species, and refers to this genus *Cyrtoneurina uber* G.-Tos, *inuber* G.-Tos, *gluto* G.-Tos, and *pellex* G.-Tos. All these species are Mexican. He also refers *Cyrtoneura anthomydea* Bigot to *Clinopera*. It seems to me that there is nothing in Bigot's description that does not apply to *Muscina assimilis* Fall., specimens of which

from the Rocky Mountains (the source of Bigot's specimen) are in my collection.

MUSCINAE MUSCAEFORMES.

1. Middle tibia with a prominent macrochaeta on its flexor surface . 2
   (The male of some European Mesembrinae has no such macrochaeta, but its middle tibiae are elongate and on their flexor surface thickly hairy.)
   Middle tibiae without such a prominent macrochaeta . . 3
2. Sternopleural macrochaetae 1 : 2; elbow of fourth vein forming a rounded angle; no orbital macrochaetae, but the geno-vertical plate uniformly beset with minute bristly hairs; transfrontal macrochaetae small and weak, often difficult to see . . . *Pseudopyrellia* Girschner.

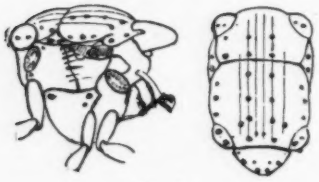


FIG. 8.

   Sternopleural macrochaetae 1 : 3; first longitudinal vein ending in the costa at about the middle of the wing; small cross-vein about opposite the end of the first longitudinal; elbow of fourth longitudinal not forming an angle but a gentle curve convex toward the hind border of the wing forming an apical cross-vein which is longer than the terminal portion of the fourth vein before its curvature . . . *Pyrellia* Desvoidy
   Sternopleural macrochaetae varying, 1 : 3, 1 : 2, 0 : 1; if (rarely) 1 : 1 then the anterior notably the smaller; first longitudinal vein ending in the costa far beyond the middle of the wing; small cross-vein a long distance basad to the end of the first longitudinal; fourth longitudinal sweeping in a broad curve, convex toward hind border of wing, towards the third, thus forming an apical cross-vein, which, however, in our species, is not longer than the terminal portion of the fourth vein before its curvature . . . . . *Mesembrina* Macquart
3. Bend of fourth longitudinal forming a rounded angle. Outline of arista as a whole fan-shaped. Sternopleural macrochaetae 1 : 2. *Musca* Linnaeus
   Bend of fourth longitudinal not forming an angle at all, but a gentle curve 4
4. Antennae separated at their base by a distinct ridge; sternopleural macrochaetae 0 : 2; eyes very distinctly hairy *Graphomyia* Desvoidy
   Antennae not thus separated; sternopleural macrochaetae 1 : 2; eyes not distinctly hairy 5
5. Arista naked . . . *Synthesiomyia* Brauer and Bergenstamm
   Arista plumose . . . . . *Morellia* Desvoidy

Pseudopyrellia (Fig. 9). — Our only known species is *P. cornicina* Fabr. I consider *Lucilia carolinensis* Desv., *L. compar* Desv., and *L. Heraea* Walk., as synonyms.

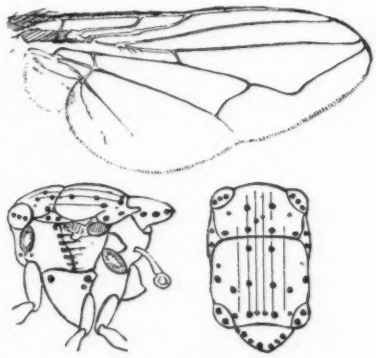


Fig. 9.

Pyrellia (Fig. 10). — The only North American species that I have seen is *P. cyanicolor* Zett. The specimens agree perfectly with the description and with European specimens from Prof. G. Strobl and others. *P. setosa* Lw. is a synonym; I have compared the types in the Agassiz Museum with my American and European specimens. Occasionally one finds a specimen which is of a rather bright metallic green instead of the usual dark steely blue, but I can find no structural or other color differences. *Musca occidentis* Walk., *Dipt. Saund*, p. 347, is probably this same species.

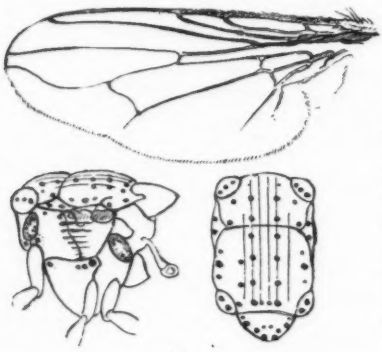


Fig. 10.

P. cadaverina L. may be distinguished from *cyanicolor* by the entire absence of any trace of hoary coating on the thorax even at the cephalic border, while *cyanicolor* has three broad hoary stripes, a median and two humeral, which are specially distinct at the cephalic border.

Mesembrina. — There is but one known North American species, which we must call *M. latreillii* Desv. (Fig. 11) because no other species is known. Desvoidy says: "Tout à fait semblable au *M. meridiana;* un peu plus petite; antennes brunes; la face est d'un argenté brillant sur les côtés." Now

the species is by no means just like *M. meridiana* (Fig. 12); it does not average smaller than that species; the antennae vary in color from yellow to brown; the sides of the face are, however, silvery. The species agrees perfectly with the description of

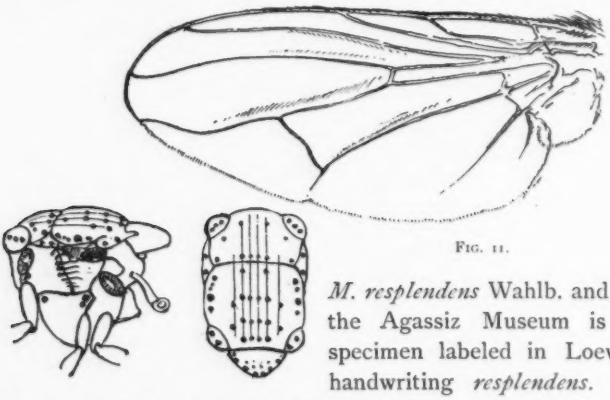


FIG. 11.

M. resplendens Wahlb. and in the Agassiz Museum is a specimen labeled in Loew's handwriting *resplendens*. I think there can be no doubt of the synonymy. Mt. Washington, N. H.; North Mt., Pa.; Seattle, Wash.; Dakota. For comparison I introduce here Fig. 13, *M. mystacea L.* If the truth could ever be known, it is highly probable that *M.*

FIG. 12.

pallida Say would be found to be an *Oestrophasia* very near or identical with *O. punctata* Coq.

M. anomala Jaennicke is evidently not a *Mesembrina* at all. Professor Brauer suggests that it belongs near *Spilogaster*.

Musca. — *M. domestica* L. (Fig. 14) is very common. Walker says that *M. corvina* Fabr. occurs in Nova Scotia. The front of *corvina* is very narrow in the male, that of the male *domes-*

tica is about one-fourth as wide as the head; the frontal vitta of the female *corvina* is of uniform width throughout, while that of the female *domestica* is narrow near the antennae and broadens out very considerably towards the vertex. Specimens from

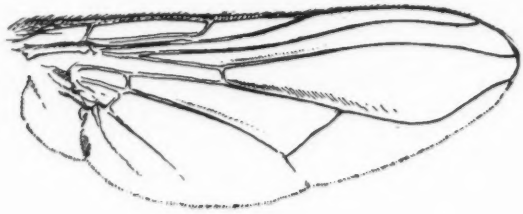


FIG. 13.

Jamaica, agreeing with Macquart's description of *M. basilaris*, are certainly *M. domestica*.

Graphomyia (Fig. 15). — Our single species does not differ structurally and has but insignificant color differences from *G.*

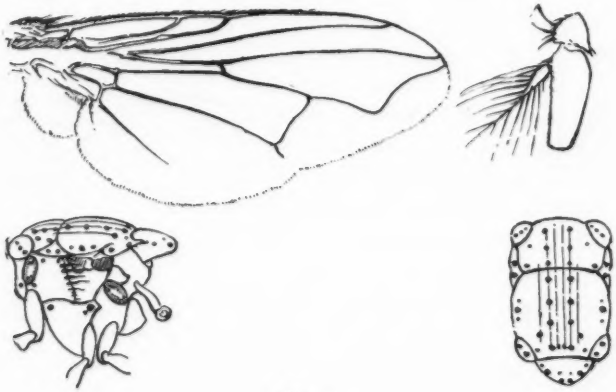


FIG. 14.

maculata Scop., with which I identify it. *G. americana* Desv. is the same species.

Synthesiomyia. — *S. brasiliana* BB. occurs in Florida and in Georgia (Fig. 16). It is the only species of the genus.

Morellia. — *M. micans* Macq. (Fig. 17) is very common all over the United States. Bluish black; thorax with three broad

hoary stripes; last abdominal segment of female brown with hoary coating. Macquart described the female only; the male resembles the female in color (except that the last abdominal segment has much less of a brown color) and has the following structural features which are characteristic: a beard of long hairs on the mesal border of the hind tarsi and a fringe of short, fine hairs on the anterior surface of the middle tibiae not far from the extensor border.

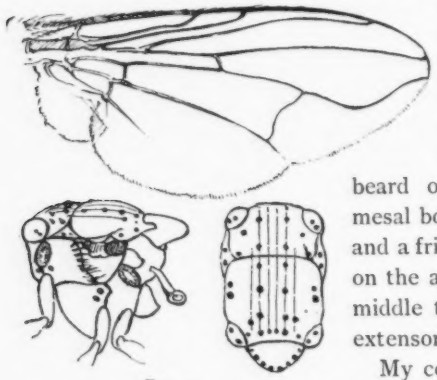


FIG. 15.

My collection contains also two species of *Morellia* from Mexico and Jamaica. One is rather variable, the variations corresponding to the descriptions of *Musca violacea* (Fig. 18) Fabr., *Pyrellia maculipennata* Macq., *P. specialis* Walk., *P. sus-*

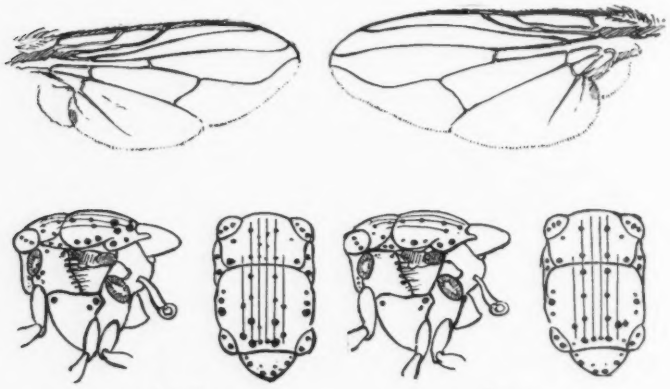


FIG. 16.

FIG. 17.

picax Walk., *P. basalis* Walk., *P. centralis* Lw. (types compared and found to agree), and *P. iris* Bigot. Fabricius's name has priority. The male has on the anterior surface of

the middle tibia, near the extensor border, a series of bristles extending from base to apex; the basal half of the series are very tiny but stout as compared with their length, real little spines; at about the middle of the series the form changes gradually to that of a delicate and moderately long bristle. This arrangement is very like that of the European *M. hortorum* Fall. My specimens of this species are from Jamaica, C. W. Johnson, and from Mexico, O. W. Barrett.

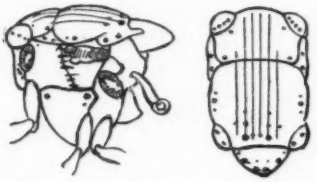


FIG. 18.

The other species agrees with the descriptions of *Pyrellia scapulata* Bigot (Fig. 19) and *P. flora* Bigot. The middle tibia of the male has some noteworthy structures. On the anterior surface at the base is a tubercle about 0.3 mm. (one-seventh the length of the tibia) long and half as broad, its long diameter parallel to that of the tibia. On this tubercle is a row of six or eight very short thick spines, and in some specimens a second row, flexad the first, of about four similar but much smaller spines, can be made out. From the apical end of the tubercle the principal row is prolonged as a series of about equal and equidistant, much more delicate spines, as far as the apex of the tibia. Just at the junction of the posterior and flexor surfaces there are three large bristles; one is at the junction of the basal and middle thirds, the second at the middle of the tibia, the third at the junction of the middle and apical thirds. My specimens of this species are from Jamaica, collected by C. W. Johnson. The name *scapulata* has priority.

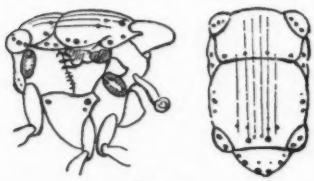


FIG. 19.

Catalogue of Muscinae Mentioned in this Paper but not Referred to in Osten-Sacken's Catalogue.

Haematobia serrata Desv., Myod., 389, 3.

Haematobia alcis Snow, *Can. Ent.*, April, 1891. Vol. xxiii, pp. 87–91.

Hemichlora vittigera Bigot, van der Wulp, Biol. Cent.-Amer. Vol. ii, p. 304.

Cyrtoneura Bigot, Bull. Soc. Zoöl. Fr., p. 613, male. 1887.

Cyrtoneurina Gigl.-Tos, Mem. R. Accad. Sci. Torino. Ser. 2, vol. xlv (sep.), p. 13, female.

Muscina assimilis Fall.

Musca assimilis Fall., Dipt. Suec., Musc., 56, 41. 1820.

Musca caesia Meigen, Syst. Beschr. Vol. v, p. 76, 43. 1826.

Muscina concolor Desv. (?), Myodaires, p. 408, 5. 1830.

Muscina fungivora Desv., *loc. cit.*, p. 408, 6.

Cyrtoneura aperta Macq., Dipt. du Nord de Fr., 11, 4. 1834.

Musca borealis Zett., Ins. Lapp., p. 660, 28. 1838–40.

Cyrtoneura caesia Meig., Syst. Beschr. Vol. vii, p. 309, 5. 1838.

Cyrtoneura aperta Macq., Meigen, *loc. cit.* Vol. vii, p. 309, 14. 1838.

Cyrtoneura caesia Meig., Zetterstedt, Dipt. Scand. Vol. iv, p. 1351, 5. 1845.

Cyrtoneura assimilis Fall., Zett., Dipt. Scand. Vol. iv, p. 1351, 6. 1845.

Cyrtoneura caesia Meig., Schiner, Fauna Austr. Vol. i, p. 597. 1862.

Cyrtoneura assimilis Fall., Schiner, *loc. cit.*, p. 598. 1862.

Cyrtoneura assimilis Fall., Rondani, Dipt. Ital. Prod. Vol. v, pp. 214 and 216. 1862.

Cyrtoneura assimilis Fall., Strobl, Dipt. Steiermark. Vol. ii, p. 76. 1894.

Muscina pallidicornis Bigot, van der Wulp, *loc. cit.*, p. 311.

Cyrtoneura pallidicornis Bigot, Bull. Soc. Zoöl. Fr. Vol. xii, p. 614. 1887.

Muscina parilis Gigl.-Tos, van der Wulp, *loc. cit.*, p. 311.

Cyrtoneurina parilis Gigl.-Tos, *loc. cit.*, p. 14, No. 154.

Muscina vecta Gigl.-Tos, van der Wulp, *loc. cit.*, p. 311.

Cyrtoneurina vecta Gigl.-Tos, *loc. cit.*, p. 14, No. 155.

Muscina linea v. d. W., *loc. cit.*, p. 304.

Muscina trilineata v. d. W., *loc. cit.*, p. 305.

Muscina texana nov. sp.

Muscina aurantiaca nov. sp.

Clinopera. Mr. van der Wulp's species are described in Biol. Cent.-Amer., Dipt. Vol. ii, pp. 305–310. He includes *C. uber* Gigl.-Tos and

inuber Gigl.-Tos in his table, p. 306, and makes some remarks on them, pp. 307 and 308. On p. 311 he refers *Cyrtoneurina gluto* Gigl.-Tos and *pellex* Gigl.-Tos to *Clinopera*. All these species of Giglio-Tos were described as *Cyrtoneurinae* in Mem. R. Accad. Sci. Torino, ser. 2, vol. xlv (sep.), pp. 14–17. *Cyrtoneura anthomydea* Bigot, Bull. Soc. Zoöl. Fr., vol. xii, p. 614 (1887), is referred by Gigl.-Tos, *loc. cit.*, p. 15, to *Cyrtoneurina*, and by van der Wulp, *loc. cit.*, p. 311, to *Clinopera*.

Pyrellia cyanicolor Zett., Dipt. Scand. Vol. iv, p. 1323, 4.

Pyrellia serena Meig., Rondani, Dipt. Ital. Prod. Vol. v, p. 203.

Pyrellia cyanicolor Zett., Strobl, Dipt. Steiermark. Vol. ii, p. 73.

Pyrellia setosa Loew, Centuriae. viii, 63.

Synthesiomyia brasiliana BB. Brauer and Bergenstamm, Vorarb. z. Monog. Musc. Schiz. Vol. iii, pp. 96 and 110.

Morellia violacea Fabr.

Musca violacea Fabr., Syst. Antl., p. 288, No. 25; Wied., Auss. Zweif. Vol ii, p. 409, 43.

Cyrtoneura violacea Fabr., Brauer and Bergenstamm, *loc. cit.*

Pyrellia maculipennata Macq., Dipt. Exot. Supp. 4, 252, 12.

Cyrtoneura maculipennata Macq., Townsend, Ann. New York Acad., p. 33. 1892.

Pyrellia iris Bigot, Ann. Soc. Ent. Fr., p. 36, female. 1878.

Pyrellia centralis Loew, Centuriae. viii, 62.

Morellia scapulata Bigot.

Pyrellia scapulata Bigot, *loc. cit.*, p. 35, female. Mexico.

Pyrellia flora Bigot, *loc. cit.* Male. Haiti.

EXPERIMENTAL STUDIES UPON HYDROMEDUSAE.

C. W. HARGITT.

Syracuse University, Syracuse, N.Y.

In connection with previous work on regeneration the problem of animal grafting was repeatedly suggested by many phenomena associated with that work, and during the summer of 1898 a series of experiments was undertaken at the Marine Biological Laboratory and carried on through the months of July and August.

It is a pleasure in this connection to acknowledge many courtesies extended by the director, Prof. C. O. Whitman, and valuable suggestions from Dr. Jacques Loeb, during the progress of the work. The following paper aims simply to present a résumé of methods and results, deferring speculative considerations which might be suggested by any of the phenomena involved.

I. *Material.*

This was restricted to two sorts of organisms, Hydroids and Medusae. Of Hydroids an almost unlimited amount and of many genera and species were available and easily obtained from the waters about the docks of the U. S. Fish Commission, from the rocks and fucus in the harbor and adjacent waters. It was obtained fresh every morning and experiments were made only upon it within a few hours. The genera used in the experiments were Eudendrium, Pennaria, Parypha, and a few of the Campanularidae.

Of Medusae only one species was available in sufficient abundance and size for experimentation, namely, *Gonionemus vertens*, a Medusa occurring in considerable numbers in the "eel pond," a small body of water adjacent to the laboratory and communicating with the waters of the harbor by a very

narrow inlet. As this Medusa endures artificial conditions with considerable ease for days and even weeks, it lends itself readily to such experiments. Its size also, varying from 2 or 3 mm. to as many cm., is also a factor of convenience, though a larger species would prove desirable in some operations. Its activity during at least three months also facilitates extended experiments.

II. *Methods.*

In grafting the Hydroids, the stems were cut into fragments varying from 5 to 10 mm. in length, and usually taken from the younger and fresher portions of the stem. Successful unions were made from older portions but in much smaller proportions, and requiring much longer time. The hydranths were excised, since the motion of the body and tentacles would invariably disturb the contact of the specimens. Having prepared suitable sections, they were brought into contact in watch-glasses, or small petri dishes, of perfectly fresh sea water, and retained in position by small bits of lead shaved freshly from thin sheets. Bits of platinum wire would have been better, though it was not available at the time, and little appreciable difficulty was had with the lead. The water was changed on the specimens daily.

FIG. 1.

With the Medusae the task was a much more difficult one, for while the power of spontaneous movement had been largely eliminated by emarginating the bell and thus removing the marginal nerve ring, and thus the centers of spontaneity, the contractility had not been destroyed, and for a time great difficulty was found in retaining the parts in even contact. And in this connection I desire to correct a partial error in my previous paper on "Regeneration,"[1] where I had failed to recognize the paralyzing effects of such emargination, a fact due to failure

[1] *Zoölogical Bulletin*, I, p. 29.

to remove sufficient of the margin. If the least portion was left, or even a portion quite near the margin, automaticity was retained, but by removing carefully and completely some 2 or 3 mm. of the bell-margin I was able to confirm quite fully the experiment of Romanes[1] on Scyphomedusae.

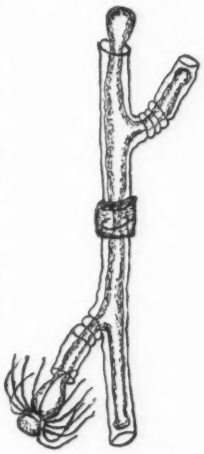


FIG. 2.

After various expedients had failed, resort was had to bits of rather fine shoemaker's bristles, cut into proper lengths. These were thrust through the gelatinous portions of the Medusae in such directions as would serve to fairly secure the desired contact of the surfaces to be united. An inspection of the several figures will give the best idea of how this was secured. *Cf.* Figs. 8 and 9. But at best the method was only partially successful. It may be mentioned in this connection that one of the difficulties attending these experiments was the danger of deleterious contamination involved in the whole of the operations from Bacteria and parasitic Infusoria invading the water and impeding or destroying the experiments. This was much more noticeable in experiments on Medusae than on Hydroids, a fact due in part, certainly, to the promptness with which the latter reacted in regeneration of tissues as compared with the former. Notwithstanding, it is rather remarkable that so small a proportion in either case suffered, since no *special* pains were taken in the way of critically guarding against contamination beyond the more ordinary provisions of clean glassware and instruments. To maintain a fairly equable temperature during unusually hot days, the covered vessels containing the specimens were set under the running water taps of the laboratory.

[1] Jellyfishes, etc., p. 27 *et seq.*

III. *Grafting.*

Hydroids. — The work upon Hydroids was restricted chiefly to species of Eudendrium, Pennaria, and Parypha, though a few experiments were tried upon Campanularians. Upon the latter the results were almost entirely *negative*, though for this no apparent cause was ascertained. The experiments were not of sufficient numbers, nor of sufficiently varied conditions, to warrant any conclusions as to the incapacity of these to regenerate or coalesce. Time was not adequate to extend the attention to this group which might have resulted more favorably. Again, the relatively small size of the members of this group available was a further embarrassment to successful experimentation. However, neither of these is offered as sufficient account of the negative character of the experiments. Indeed, the work of Davenport ('94) on Obelia is strongly affirmative, at least so far as regeneration is concerned.

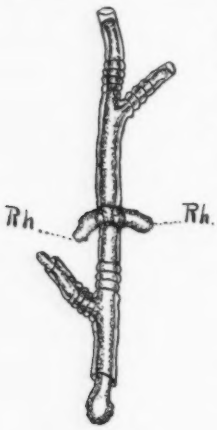


FIG. 3.

Experiments upon species of the genera named were specially successful. While of course in all such work a large number of failures must result, yet when the difficulties of manipulation and the artificial conditions necessary are considered, this is not strange.

While no mathematical estimates were made as to the ratio of successful experiments, I think it may be safely said that at least 20 per cent of all were successful. It need hardly be pointed out that results varied materially in both the time necessary, and the degree of perfection, in the coalescences. This will be noted in detail in connection with the several experiments described.

A comparison of the several figures will perhaps indicate in general better than words the methods and results. *Cf.* Figs. 1–6.

The union between sections of the same species was usually quite perfect within from eighteen to thirty-six hours. A

delicate sheath of perisarc secreted over the ends was the first indication of special activity and regeneration. This usually occurred at any wounded point. It became specially marked at the points of contact of the grafted specimens. The first effect of the sectioning of the specimens preparatory to their being placed in contact was a pronounced contraction of the coenosarc within the tubular perisarc, and the closure of the cut ends of the enteric cavity. This was usually, however, soon followed by an outgrowth till the coenosarc of the two specimens came into contact, when the secretion of the extra perisarc proceeded as a joint operation, though sometimes by a single one, if its activity and response were the more prompt. *Cf.* Figs. 1 and 2.

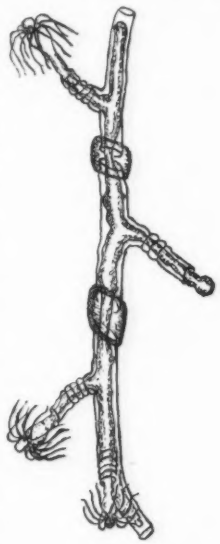


FIG. 4.

Following this the contact of the two became more intimate, the healed ends united with each other, fusion being followed by the absorption of the terminal portions and the consequent confluence of the enteric channels and their contents.

In the experiments no apparent difference was noticeable as to anything like polarity, the parts uniting orally, aborally, or otherwise, with equal freedom and promptness. With species of Eudendrium and Pennaria this was demonstrated with absolute certainty, the directions of the branches making any mistaking impossible. *Cf.* Figs. 2–4.

In these species the sexes are distinct, and experiments in grafting specimens of the opposite sexes were quite as prompt and perfect as otherwise. There would seem, therefore, to be not only no definite differences of polarity as seems to be the case in Hydra, but no sexual difference in so far as regenerative or coalescence capacity is concerned. It remains to note results as to grafting different species. With none of these are the distinctions sufficiently clear to warrant positive con-

clusions. Of Pennaria, only one species was available, and the same was true of Parypha. Of the species of Eudendrium there have been several indicated, but their distinctness is to my mind open to serious doubt.

If the distinctness of Agassiz's species of *E. dispar* and *ramosum* is to be maintained, then the grafting of these has been as clearly established as that of the different sexes. It would not be strange should closely allied, though definitely distinct, species be found to coalesce in these organisms, for such has been long known among plants, and shown for animals by the recent experiments of Born ('96), Crampton ('97), Harrison ('98), and others. But so far as I am aware it has not hitherto been demonstrated for the Hydroids; indeed, most of such efforts have been negative in results.

FIG. 5.

As to the coalescence between specimens of different genera, the experiments seem to be conclusive and wholly negative. Out of a considerable series, while there were indications of temporary union, in no case did it become conclusively permanent. The most favorable indications were upon Eudendrium and Pennaria, Hydroids of very similar size, structure, and habit; but after repeated experiments under different conditions the results were as already indicated. In Fig. 6 it will be noted that the usual secretion of perisarc at the points of contact has been deposited, and apparently by the coöperation of both sections; still at no time were there evidences of organic union of the coenosarc, and later this was distinctly withdrawn, and the sections continued an independent existence, each producing new hydranths, though in the case of Eudendrium they continued rudimentary in the specimen figured.

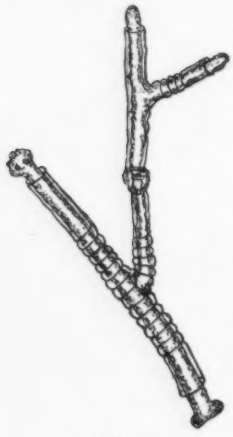


FIG. 6.

IV. *Medusae.*

Experiments upon Medusae were restricted to *Gonionemus vertens*, being the only species available in sufficient numbers, and capable of adaptation to the artificial condition necessitated by the nature of the work. This Medusa is found in great numbers, though only in a limited locality adjacent to the Marine Laboratory, and lives readily for several days, or even weeks, in table aquaria, if reasonable precautions be taken to keep the water fresh and supply suitable food.

While the experiments were quite extensive and various, aiming at first to ascertain the trend of resultants, no attempt will be made in this connection to describe them in any con-

FIG. 7.

FIG. 8.

siderable detail, but rather to call attention to a few of the more conspicuous of them, and to indicate something of their probable significance.

Fig. 7 will afford a good idea of the general features of the Medusa with the entire margin of the bell and its organs excised, preparatory to any contact experiments.

In Fig. 8 are shown two Medusae from which portions have been removed, the larger part of each being brought into contact and retained by the bristle, *br.*, passing through the body. In some instances two or three bristles were passed through in different planes, thus giving greater stability of contact.

Parts of various sizes and from different regions were similarly grafted, and with usually similar results. The time required for union differed greatly in experiments conducted under exactly the same conditions and care. In some cases complete union had taken place within twenty-four hours, while in others it only occurred after several days. It should be noted, however, that when once coalescence had begun it usually went forward with comparatively great rapidity.

In Fig. 9 is shown the coalescence of two Medusae by their oval margins. This was usually the most easily performed of any of the experiments upon the Medusae, and union was rather more prompt if any difference was noticeable. As will be seen from the figure, fusion was not entire in this case, a small mouth-like opening remaining on one side through which aëration of the interior was made possible, and by means of which by contraction the united individuals were able to move about in the water. It should be noted in this connection that upon stimulation coördinated movements were produced, and in a few instances even apparently spontaneous movements were clearly recognized. I have said that this action was *apparently* spontaneous. It is not impossible, of course, that some extraneous stimulus might have been involved, but, if so, it was wholly beyond any ordinary physical detection, and was distinctly recognized by several persons to whom it was pointed out.

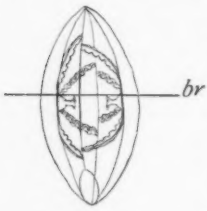


FIG. 9.

In these experiments, in a few cases, the specimens united completely throughout the entire margin, but with the result that the specimen died within a comparatively short time, presumably from inability to secure aëration of the portions where metabolism was most active and aëration most imperative.

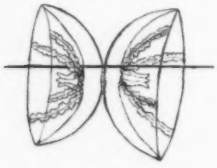


FIG. 10.

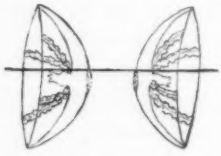


FIG. 11.

Figs. 10 and 11 show a method of aboral grafting made upon a considerable number of specimens, but uniformly without permanent success. As will be noted in Fig. 11, the points of contact were slightly scarified, or in some cases portions excised with sharp scissors, in order to favor coalescence of

the surfaces, but after a few hours the specimens would almost invariably have drawn apart by some sort of creeping movements, probably aided in part by the prehensile character of the manubrium, and usually one or both finally extracting the bristle entirely. I am not able to suggest any satisfactory explanation of the negative character of this experiment. Whether regenerative tissue is wanting on this area, or whether some intrinsic repugnance to such fusion be the cause or occasion, or whether some cause wholly undetected was present, seems a matter of doubt. There would seem to be no *a priori* reason why this particular experiment should not find as ready a response as those already described. The inverted position could hardly be assigned, for specimens in similarly inverted aspects readily united by the margins, as indicated in Fig. 12.

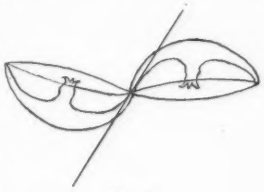


FIG. 12.

In Figs. 13–16 is shown a phenomenon which appeared in connection with the series of experiments quite incidentally, and of which I shall undertake no particular explanation, and yet which is one of the most novel and interesting of the entire series.

FIG. 13.

FIG. 14.

FIG. 15.

FIG. 16.

In certain aboral grafts, similar to those already described in Fig. 10, a single specimen was found with the bell somewhat evaginated, as in Fig. 13. During the following days, July 27 and 28, it passed successively through the phases represented in Figs. 14, 15, and 16, becoming permanently united in the completely evaginated form of Fig. 16, in which condition it continued to live and even take particles of food, though it showed no evidences of growth, beyond a distension of the gastric pouch due to the engulfed food. Finally, on August 3 the specimen died during the very sultry night, and was found the

following morning in a partially disintegrated condition, a result due in part to the unusual temperature, and perhaps in part to overfeeding.

A series of experiments were undertaken by which to secure, if possible, by artificial means other inversions of a similar sort, and though various expedients were adopted by which to facilitate such, they gave no permanent results.

The phenomenon of eversion in the Medusae of Obelia and other Hydroids in their young or newly discharged condition is quite well known, but it continues for a brief time only, and with no disposition toward permanence so far as I have known.

Of course the classical experiments of Trembley (**1744**), Nussbaum ('**87**, etc.), and others upon Hydra are too well known for special comment, and at first sight might be thought to be analogous to that now under consideration ; but a moment's reflection will suffice to show that it is only so in a very general way. For example, there is no inversion of the relative position of ectoderm and endoderm, since the lining of the bell, outer surface of the manubrium, etc., is ectodermal. The enclosed cavity of the everted specimen served no new function in its changed condition, nor did the outer layer in its new relations. That any change in the histological characters would be induced may therefore be considered very unlikely since the change of relative position, while considerable, is yet not such as would necessitate any change of function. Nevertheless the fact is an interesting one, and apparently quite unique. At one time, just about the completion of union of the inverted margins, a decided papilla-like bud appeared at the aboral area which presented some resemblance to a second manubrium, but this soon after was absorbed entirely, and was probably only the elevation due to the approximation of the margins preparatory to final union.

V. *Regeneration and Heteromorphosis.*

In connection with the foregoing experiments occasion was taken to repeat some of my earlier experiments on regeneration and to extend them somewhat. At an earlier point in

this paper I have indicated an error in the former paper, as to the paralysis of the Medusa following the complete removal of the marginal portion of the bell. I desire, moreover, to express more definitely than appears in the earlier paper, though it was clearly implied at several points, the fact that in all those experiments there does not appear to be any actual increase of mass, or growth of the body as a whole, but that in all the regenerative activity it was evidently at the expense of other portions of the body proper. This would naturally follow in most cases, since in producing a new manubrium, or new tentacles, or in the grafting experiments, the animal was practically incapacitated for obtaining food, and under the artificial conditions of the experiment could hardly have been sufficiently fed to make evident any growth. In many cases a very evident decrease in size was apparent in the progress of the experiment. Indeed, in many cases manubrium, velum, tentacles, etc., continued to live for weeks accompanied by a gradual decrease in the body mass, till it finally became wholly consumed, after which the organs gradually disintegrated.

FIG. 17.

In all essentials the later experiments confirm those earlier made. Further attempts were made to put specimens under such conditions as would render difficult any mere contraction or approximation of the surfaces. Figs. 17 and 18 will show two out of a considerable number and variety of the experiments. In these the portions of the body were set in their relative positions by bristles in such a way that only continued contractions of considerable vigor would be able to change them. But within forty-eight hours the results indicated in the several figures had taken place, the stereotype form of body assumed,

and without indication of specific regenerative growth and absolutely no hint at heteromorphism in the slightest way.

Figs. 19 and 20 show experiments designed to further test the regeneration of the manubrium. The operation of removing the organ was made on August 4. As will be seen in the case of Fig. 19, about three-quarters of the animal were excised, leaving one chymiferous canal fairly complete, and a mere remnant of a second, the whole of the manubrium hav-

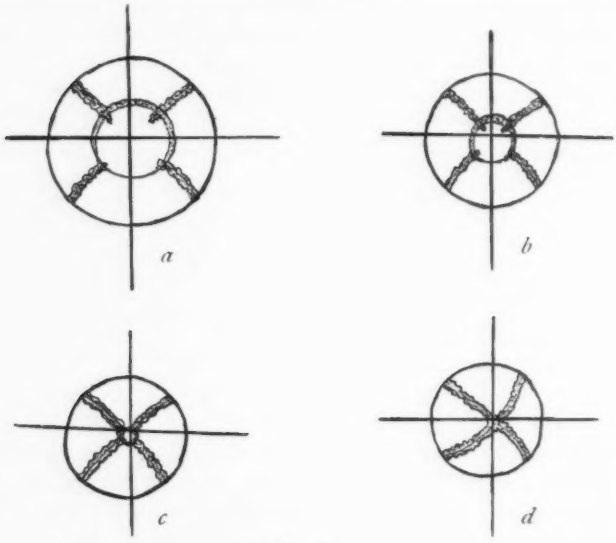


FIG. 18.

ing been removed, as indicated by the line of the cut, *a-b*. In Fig. 20 a wedge-shaped piece, about one-fourth the body mass, including the manubrium, one entire canal and the central portions of the other three, as indicated, was excised.

On August 5 the cut margins in each case had approximated each other and were evidently uniting. On August 7 the union was complete and the Medusae were swimming quite freely and naturally. On August 9 the first indications of a new manubrium were apparent, and in approximately the normal position. Its color and texture clearly indicated its forma-

tion as a new outgrowth, there being only the slightest traces of pigment present. The growth was quite gradual, and not until about August 14 had it become fully formed and functional.

In each case there had also been regenerated additional radial canals, as indicated in the figures. These appeared in connection with the lines of union, and were not at first

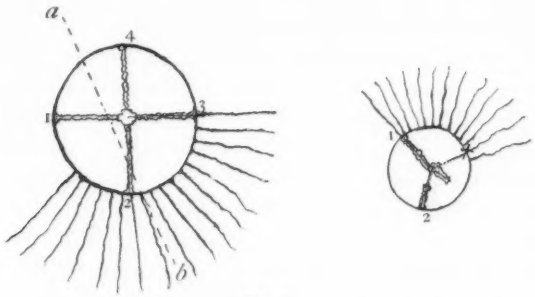


FIG. 19.

suspected as canals. Later the deposition of pigment along their course pointed strongly to the conclusion that they were canals, though whether yet functional I am not able to say.

In none of my experiments has there been any clear confirmation of the results and conclusions of Bickford ('94) that in Hydroid regeneration the polyp, tentacles, etc., are produced

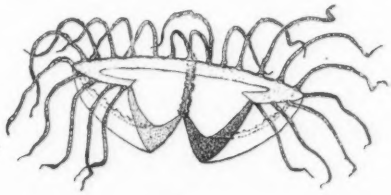


FIG. 20.

simply by a "transformation of the tissues of the stem"—that is, that the tentacles are formed by a sort of longitudinal cleavage of the coenosarc, and a remolding of it directly, without any tissue changes. In cases where there is only a recasting of a portion of the body into the *form* of the original, as in the case of a Medusa divided into sections, where each

part assumes the typical shape of the whole, being only different in *size*, this is of course clear. But from an inspection of Fig. 1 it will be evident that the tentacles are regenerated by a process of budding and growth exactly as in Hydra. The same was even more evident in the regeneration of tentacles, manubria, etc., in the Medusae. In every case they originate as minute buds, and become functional only after a considerable period of growth.

Whether additional tissue is formed from "*a few undifferentiated cells*," a sort of reserve embryonic tissue, may indeed be doubtful. Still, that there is *growth* in the ordinary histogenic sense must be evident in these cases as truly as in that of the regeneration of the tail or limb of the newt. And, indeed, it hardly seems to be more than a verbal quibble whether it be by one or *both* processes. For in either case it simply implies the presence in these organisms of cells or tissues possessing the capacity, shared in common with embryonic or undifferentiated tissues, of reparation.

VI. *Historical.*

Experimental work on the Hydrozoa may be said to date from the classical researches of Trembley, published in 1744, upon species of Hydra. He divided specimens into pieces of various sizes and shapes, and from various portions of the body, securing entire polyps from each.

He turned polyps inside out and had them live and thrive for months. He also grafted portions of one upon another with equal facility and success.

These researches were later repeated by Baker, who, while confirming some of Trembley's experiments, was not able to do so for all of them. Similar results were had by Rösel von Rosenhoff in 1755, who in addition claimed to have secured entire polyps from fragments of tentacles.

In 1878 Engelmann again repeated Trembley's experiments, and with results very similar to those of von Rosenhoff.

Marshall in 1882 was not able to secure successful grafting or eversion, but regeneration of polyps from portions of ten-

tacles, the body of the tentacle becoming the body of the polyp, and in turn forming new tentacles.

Nussbaum in 1887 and 1890 successfully everted specimens and described the process by which the body layers righted themselves. He secured no regeneration from detached tentacles.

Ischikawa in 1889 experimented upon eversion of Hydras successfully and described the process by which the layers readjusted themselves, differing in some respects from the account of Nussbaum.

In 1895 and 1898 Wetzel grafted specimens and secured union between portions of same species; but while bits of a different polarity united, the distinctness of polarity was only exceptionally modified. He secured only temporary unions of portions of different species.

Miss Peebles in 1897 undertook the determination of the smallest portions of Hydra capable of regeneration.

Rand in 1898 worked out interesting results on the "Regulation" of regeneration in Hydra.

Comparatively little has been done of an experimental nature upon Hydroids.

Loeb in 1891 carried on an extensive series of experiments on regeneration and heteromorphosis among Hydroids, chiefly of the genera Antennularia, Eudendrium, and Tubularia, with the object of determining as far as possible the external conditions and causes which affect life and growth. Light and gravitation were shown to have a profound influence in determining many of the phenomena.

In 1892 Miss Bickford conducted experiments on *Tubularia tenella*, confirming in many points the work of Loeb.

Davenport in 1894 conducted regenerative experiments upon *Obelia commisuralis*, with a view to determining the distribution of generative or embryonic tissue in various regions of the Hydroid.

The contribution of the present writer to the general subject in 1897 has already been cited.

Driesch in 1897 reviewed the work of Loeb and Bickford on Tubularia.

Summary and Conclusions.

1. Tubularian Hydroids readily react to experiments directed toward regeneration or grafting.

2. They exhibit in most cases striking illustrations of heteromorphosis.

3. They show no marked polarity, readily coalescing in either oral or aboral relations.

4. They show no sex differentiation of tissues limiting the process of grafting.

5. Closely allied species may be intergrafted.

6. Different genera have not been successfully grafted.

7. Hydromedusae respond to regenerative and grafting experiments with almost equal readiness.

8. No definite aboral grafting of Medusae has been successfully made.

9. Medusae show throughout a sharp polar orientation.

10. No heteromorphic results have been shown among Medusae.

SYRACUSE UNIVERSITY, June, 1899.

LITERATURE CITED.

1. 1896. BORN. Ueber Verwachsungsversuche mit Amphibienlarven. *Archiv f. Entwick.* Bd. iv, p. 349.

2. 1897. CRAMPTON. Biological Lectures.

3. 1894. DAVENPORT. Regeneration in Obelia and its Bearing on Differentiation in the Germ-Plasma. *Anat. Anzeiger.* Bd. ix, p. 283.

4. 1897. DRIESCH. Studien über das Regulationsvermögen der Organismen. *Archiv f. Entwick.* Bd. v, p. 389.

5. 1878. ENGELMANN. Ueber Trembley's Umkehrungsversuch an Hydra. *Zool. Anzeiger.* Jahrg. i, p. 77.

6. 1897. HARGITT. Recent Experiment on Regeneration. *Zoöl. Bull.* Vol. i, p. 27.

7. 1898. HARRISON. Growth and Regeneration of Tail of the Frog Larvae. *Archiv f. Entwick.* Bd. viii, p. 430.

8. 1889. ISCHIKAWA. Trembley's Umkehrungsversuch an Hydra nach neuen Versuchen erklärt. *Zeit. f. wiss. Zool.* Bd. xlix, p. 433.

9. 1891. LOEB. Untersuch. z. physiologischen Morph. der Thiere. Würzburg.

10. 1896. LILLIE. On the Smallest Parts of Stentor Capable of Regeneration. *Journ. Morph.* Vol. xii, p. 239.

11. 1882. MARSHALL. Ueber einige Lebenserscheinungen des Genus Hydra. *Zeit. f. wiss. Zool.* Bd. xxxvii, p. 664.

12. 1887. NUSSBAUM. Ueber die Theilbarkeit der lebendigen Materie, etc. *Archiv f. Mikr. Anat.* Bd. xxix, p. 265.

13. 1890. NUSSBAUM. Die Umstülpung der Polypen. *Archiv f. Mikr. Anat.* Bd. xxxv.

14. 1891. NUSSBAUM. Mechanik der Trembleyschen Umstülpungsversuche. *Archiv f. Mikr. Anat.* Bd. xxxvii, p. 513.

15. 1899. RAND. Regeneration and Regulation in *Hydra viridis*. *Archiv f. Entwick.* Bd. viii, p. 1.

16. 1897. PEEBLES. Experimental Studies on Hydra. *Archiv f. Entwick.* Bd. v, p. 794.

17. 1744. TREMBLEY. Mem. pour servir a l'histoire d'un genre de Polypes, etc.

18. 1895. WETZEL. Transplantationsversuche mit Hydra. *Archiv f. Mikr. Anat.* Bd. xlv, p. 273.

19. 1898. WETZEL. Transplantationsversuche mit Hydra. *Archiv f. Mikr. Anat.* Bd. lii, p. 70.

20. 1896. LOEB. Ueber den Einfluss des Lichtes auf die Organbildung bei Thieren. *Archiv f. Physiol.* Bd. lxiii.

21. 1894. BICKFORD. Notes on Regeneration and Heteromorphosis of Tubularian Hydroids. *Journ. Morph.* Vol. ix.

BIBLIOGRAPHY AND PUBLICATION.

Zoölogical Bibliography and Publication. — Second Report of the Committee, consisting of Sir W. H. Flower (*Chairman*), Professor W. A. Herdman, Mr. W. E. Hoyle, Dr. P. L. Sclater, Mr. Adam Sedgwick, Dr. D. Sharp, Mr. C. D. Sherborn, Rev. T. R. R. Stebbing, Professor W. F. R. Weldon, *and* Mr. F. A. Bather (*Secretary*).

The Committee wishes to state clearly that it has no wish, even if it had the authority, to lay down laws for zoölogists or for publishing bodies and editors. It is, however, plain that many are grateful for some guidance, and the Committee hopes that it may serve as a medium for conveying to those who need it the general opinion of the experienced. There are also difficulties which, though they appear to some insuperable, may possibly be surmounted in ways that have been communicated to the Committee.

(1) 'That each part of a serial publication should have the date of actual publication, as near as may be, printed on the wrapper, and, when possible, on the last sheet sent to press.'

Five correspondents do not see the use of this, thinking that the date on the wrapper is enough, and that in the case of annual publications the date of the year suffices. The Committee would point out that wrappers are constantly lost in binding, and that periodicals are often broken up by specialists or secondhand booksellers, the consequent loss of date causing much trouble to workers of a later day. To avoid this, the Cincinnati Society of Natural History would add the date at the head of each paper, while *Natural Science* prints the month and year across every page opening. Some societies, *e.g.*, the Philadelphia Academy, issue a certificate of dates at the end of the volume. The Liverpool Biological Society 'put at the head of each paper the date when it is read, and are willing to add the date when it is printed off'; neither of these dates are necessary, and they may be misleading. In most cases the actual day of publication is immaterial, especially in cases where no new species are described, but at least the month should always be given, and the Committee does not see that there need be any difficulty in doing

this. If some unforeseen delay does occur, the date can always be rectified with a date stamp.

> (2) 'That authors' separate copies should be issued with the original pagination and plate numbers clearly indicated on each page and plate, and with a reference to the original place of publication.'

The Committee believes this to be a most important recommendation, and its view is supported by all the zoölogists consulted. Nevertheless, many leading publications continue to issue authors' copies repaged, and often without reference to volume number, date, or even the name of the periodical. The remedy is so simple that the Committee urgently appeals for its universal application.

> (3) 'That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.'

It is a curious fact that on this question editors take a different line to working zoölogists. All the latter who have discussed the matter agree with the Committee as to the extreme inconvenience caused by the general custom. Among the editors, however, nine (*i.e.*, nearly one-quarter) protest against the present recommendation. The objectors represent small societies which publish at lengthy intervals, and their reasons are: that it is not fair to an author to prevent him from receiving his separate copies for perhaps a year; that it is not to the advantage of science that work should thus be delayed; that a society which did this would receive fewer contributions and lose its members. In brief, the argument is: 'We are too poor to publish properly; therefore we must allow authors to publish improperly.' This form of argument suggests an easy remedy, and one that, on the informal suggestion of the Committee, has already been put into practice by the Liverpool Biological Society and by the R. Physical Society of Edinburgh. The remedy is this:

In cases where a volume or part can only appear at long intervals, each author that requires separate copies of his paper for private distribution before its publication in the volume or part should be permitted them only on this condition — that, for every month before the probable issue of the volume, a certain number of copies — say five — should be placed by him in the hands of the society or its accredited publisher, in order that they may be offered for sale to the public at a fixed price. Further, that the society, for its part, should announce the publication, with price and

agent, of their papers to some recognized office, or to some such paper as the Zoologischer Anzeiger. The details of expense must be settled between the author and the society.

(4) 'That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.'

It is satisfactory to find no objections raised to this recommendation, since there is no doubt that there is room for much improvement in this direction. Such phrases as 'Further contributions towards our knowledge of the . . . ,' or 'Einige Beobachtungen über . . . ,' or 'Essai d'une Monographie du genre . . . ,' might well be dispensed with as superfluous. The ornithologist who, in 1895, published a book with a title of ninety-one words would seem to have forgotten the functions of a preface.

On the other hand, it is pointed out that certain periodicals, such as the *Bulletin de la Société Entomologique de France* and the *Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin*, publish communications without any title, to the constant confusion of naturalists. The Committee begs to urge the reform of this practice, in which it can see no advantage.

(5) 'That new species should be properly diagnosed, and figured when possible.'

The only comment on this is the proposed omission of the words 'when possible.' With this the Committee sympathize, but wish to avoid all appearance of laying down a law that would constantly be broken.

(6) 'That new names should not be proposed in irrelevant footnotes or anonymous paragraphs.'

Naturally nobody supports such actions as are here objected to, but since some have doubted the possibility of the latter, it is as well to state that the suggestion was based on an actual case occurring in the Report of a well-known International Congress. The proposal of a new name, without diagnosis, in a footnote to a student's text-book, or in a short review of a work by another author, is a by no means rare occurrence. The Committee believes that such practices are calculated to throw nomenclature into confusion rather than to advance science.

(7) 'That references to previous publications should be made fully and correctly if possible, in accordance with one of the recognized sets of rules for quotation, such as that recently adopted by the French Zoölogical Society.'

Dr. Paul Mayer, of Naples, writes: 'Most authors are extremely idle in making good lists of literature themselves, and even oppose my correcting them according to our rules. There ought to be some training in this at our Universities.' This is confirmed by one or two other editors, but not all have the energy of Dr. Mayer. Some, indeed, oppose the word 'fully' on the ground that it leads to waste of time and space. The Committee would explain that the reference to a particular set of rules was intended merely as a guide to those who have not had the training that Dr. Mayer would like to see; they would also point out, in the words of the editor of the Cincinnati Society of Natural History, that 'what may be intelligible to the specialist is very puzzling to the general student.' Nowadays, when so many zoölogists work with the aid of authors' separate copies, it is an enormous convenience to them to have the title of the paper at least indicated, and not merely the volume, date, and pagination given. The Committee, therefore, cannot agree that this suggestion involves a waste of time.

Communications with reference to this Report should be addressed to F. A. Bather, Natural History Museum, Cromwell Rd., London.